

## APPLICATION UNDER UNITED STATES PATENT LAWS

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Invention: Capping Unit For Closing Containers With Respective Caps

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This is a:

- ☐ Provisional Application
- ☐ Regular Utility Application
- ☐ Continuing Application
  - ☐ The contents of the parent are incorporated by reference
- ☒ PCT National Phase Application
- ☐ Design Application
- ☐ Reissue Application
- ☐ Plant Application

## SPECIFICATION

This application claims priority to Italian Patent application number BO2003A00432,  
filed July 17, 2003, which is incorporated by reference herein.

Description

A capping unit for closing containers with  
respective caps

Technical Field

The present invention relates to a capping unit for closing containers with respective caps.

In particular, the invention finds application in systems for filling containers designed to hold  
5 substances and/or products consisting in liquids, viscous fluids, creams, gels and/or powders.

Background Art

The prior art embraces capping units such as will apply caps automatically to respective containers, consisting generally in a plurality of capping  
10 assemblies set in motion on a carousel rotatable about a vertical axis.

By way of example, European Patent EP 0636573 owned by the present applicant discloses a unit in which each capping assembly is set in rotation, about  
15 a respective axis parallel to the axis of rotation of the carousel, by a respective shaft capable of axial movement relative to the carousel in such a way that the assembly can be shifted toward and away from a relative container revolving on the carousel.

Each capping assembly is equipped with a relative mechanism such as a gripper, by means of which the cap is clasped and screwed onto the threaded neck of a respective container by inducing a rotation of the  
5      aforementioned shaft.

The carousel consists substantially in a frame carrying a vertical main drum and a platform at the top of the drum. The frame also serves to support the containers, each aligned beneath a respective capping  
10     assembly.

The shafts of the single capping assemblies are carried by a housing associated with the top platform and equipped internally with a stationary drum cam surmounting the main drum of the carousel.

15     The drum cam presents a side wall affording annular groove cam profiles, such as will accommodate following rollers connected to the shafts of the single capping assemblies and able thus to bring about their vertical movement, also a ring gear  
20     integral with the outer surface presented by the side wall of the drum cam. Each of the shafts supporting a capping assembly carries a pinion in mesh with the ring gear of the drum cam.

Thus, when the drum is set in motion around the  
25     axis of rotation, the interaction of each pinion with the fixed ring gear of the drum cam will cause the capping assembly to rotate about its own axis. The vertical and rotational movement transmitted to the shafts of the capping assemblies and the movement of  
30     the associated grippers are all synchronized in such

a manner that successive caps can be taken up by the grippers and screwed onto the respective containers.

The cap is screwed onto the container applying a predetermined tightening torque beyond which a torque limiting device, for example an adjustable clutch associated with each assembly, will begin to slip and thus allow the grippers to lock and terminate the step of screwing the cap onto the neck.

Capping units of the type outlined above are effective, but affected nonetheless by significant drawbacks.

In reality, whilst the aforementioned capping units are able to effect a secure closure of the cap on the container, the applicant finds that there are certain shortcomings as regards the versatility of such units, in terms of the extent to which they can be used with containers of different sizes.

More exactly, it will be appreciated that the vertical travel of each capping assembly depends on the profile of the groove afforded by the drum cam, which positions each capping assembly at a given height, enabling the gripper to engage the cap.

This means that if containers of different height are fed onto the carousel, the drum cam cannot be used as it will no longer be possible to position the gripper at the height of the new container. Generally speaking, the capping unit will utilize a carousel adapted to the size of a given container, with a cam profile allowing the gripper to be positioned at the correct height.

Consequently, the production line must be equipped with a number of units, each dedicated to a certain size of container, generating an increase in costs and a requirement for additional space in which to accommodate the various distinct units.

Another drawback stems from the construction costs and the overall dimensions of the single dedicated capping units.

This drawback is attributable to the use of mechanical components by which each of the individual capping assemblies is set in rotation; besides being bulky and cumbersome, the components in question are particularly costly and require frequent maintenance.

In effect, the mechanical components in question are precision-engineered parts calling for particular care in assembly, in order to ensure that each cap will be closed accurately on the container. A case in point is the adjustable clutch, for example, which not only must be set up for each production run according to the type of container and cap, but is also made to extremely high specifications and thus notably expensive.

The object of the present invention is to overcome the problems associated with the prior art by providing a capping unit for closing containers with respective caps, such as will be versatile and suitable for use with any type of container, irrespective of size.

In particular, one important object of the present invention is to set forth a capping unit such as will

be adaptable easily to any type of container used in production, regardless of the dimensions.

A further object of the present invention is to provide a particularly economic and compact capping unit, though without losing the functional advantages typical of the prior art.

#### Disclosure of the Invention

These objects and others besides, which will emerge more clearly from the following specification, are substantially realized in a capping unit according to the present invention.

The invention will now be described in detail, by way of example, with the aid of the accompanying drawings, in which:

-figure 1 is a schematic plan view of the capping unit according to the present invention, installed on a container-filling production line;

-figure 2 shows the capping unit in perspective, with certain parts omitted better to reveal others;

-figure 3 is an elevation view of the capping unit shown in figure 2;

-figure 4 is an elevation view showing a detail of the capping unit in a respective first operating condition;

-figure 5 is an elevation view showing the detail of figure 4 in a respective second operating condition;

-figure 6 is a block diagram of the capping unit.

Referring to the accompanying drawings, 1 denotes a capping unit according to the invention, in its

entirety, for closing containers 2 with respective caps 3.

Each container 2 comprises a body presenting an externally threaded neck 4, and a cap 3 threaded internally in its turn and attachable thus releasably to the neck 4 of the body. The containers 2 can be of any given type, such as flacons or bottles, or even cartons fashioned of paper material and furnished with a welded neck closed by a respective plastic cap.

With reference to figure 1, which shows the capping unit 1 installed in a production line, the unit 1 comprises a carrier and conveyor component 5 mounted in such a way as to rotate clockwise, as seen in figure 1, about a vertical primary axis 5a. The carrier component 5 receives a succession of containers 2 and a separate succession of caps 3 from a rotary infeed conveyor 100 operating at a first transfer station.

The infeed conveyor 100 is set in rotation, turning anticlockwise as seen in figure 1 about an axis parallel to the primary axis 5a, and in receipt of a succession of containers 2 taken up at a first infeed station 101 from a horizontal duct equipped with a screw feeder 102 by which the containers are directed at regular intervals into the station 101.

Also directed onto the infeed conveyor 100, at a second infeed station 103, is a succession of caps 3 entering along a horizontal duct 104 extending perpendicular to the screw feeder 102.

The carrier component 5 is disposed and configured in such a way as to effect the assembly of the caps 3 with the relative containers 2 and to direct each container 2 fitted with a relative cap 3 onto a rotary outfeed conveyor 105 by way of a second transfer station 106.

As discernible to better advantage in figure 2, the component 5 carrying and conveying the containers 2 is set in motion by a respective motor 6 of familiar in embodiment, illustrated schematically in the drawing.

More exactly, the carrier component 5 is embodied as a carousel 7 presenting a drum 8 of cylindrical geometry associated with the aforementioned motor 6 and rotatable thus about the primary axis 5a.

Also forming part of the carousel 7 is a base 9, located below the drum 8, on which the containers 2 are supported as they advance ordered in single file each with the relative neck 4 directed upwards.

More precisely, the base 9 is of substantially circular appearance and presents an annular carrying surface 9a disposed transversely to the longitudinal dimension of the drum 8 and directed toward the selfsame drum. The peripheral edge of the annular surface 9a presents a plurality of seats 9b, each designed to accommodate a respective container 2 and hold it in a vertical position.

The carousel 7 further comprises a platform 10 associated with the top of the drum 8 and positioned facing the base 9.

In a preferred embodiment, the platform 10 likewise will be of circular appearance, presenting a first annular surface 10a disposed parallel with and facing the base 9, and a second annular surface 10b facing  
5 in the opposite direction to the first surface 10a.

The capping unit 1 also includes a plurality of capping assemblies 11 associated with the carrier component 5, each positioned above a corresponding container 2. Each capping assembly 11 is capable of  
10 vertical movement in a manner that will be made clear in due course, between a first position, distanced from the respective container 2, and a second position actively engaging the container 2.

Notwithstanding figure 2 shows just one capping  
15 assembly 11 associated with the carrier component 5, for the sake of clarity, the capping assemblies 11 will advantageously be equal in number to the containers 2 standing on the base 9 and distributed around the full peripheral length of the platform 10.

20 In greater detail, each capping assembly 11 presents a rod 12 accommodated slidably within a guide 13 afforded by the platform 10.

The rod 12 extends longitudinally parallel to the primary axis 5a of the unit 1 and presents a bottom  
25 first end 12a located between the first surface 10a of the platform 10 and the annular surface 9a of the base 9, also a top second end 12b, opposite from the first end 12a, located above the second surface 10b of the platform 10.

30 The second ends 12b of the rods 12 are associated

with first drive means 14 by which the single capping assemblies 11 can be set in motion vertically, one independently of another.

To advantage, such first drive means 14 include a plurality of primary electric motors 14a each associated with a respective rod 12.

In particular, each primary electric motor 14a is associated with the second end 12b of the respective rod 12 and positioned above the second surface 10b of the platform 10.

Still more particularly, and as better illustrated in figure 3, the primary electric motor 14a presents a shaft 15 rotatable about an axis extending normal to the primary axis 5a, and a gear 15a keyed to this same shaft 15.

Positioned thus, the gear 15a is able to engage in mesh with a rack 16 offered laterally by the second end 12b of the rod 12.

To advantage, setting the gear 15a in rotation will cause the rod 12 to shift vertically toward and away from the container 2.

Also associated with each capping assembly 11 is a gripping mechanism 17 designed to engage a respective cap 3 when the selfsame assembly 11 occupies the second position. The gripping mechanism 17 is rotatable about a respective secondary axis 17a parallel to the primary axis 5a, as will be explained shortly in more detail, in such a way as to screw the cap 3 onto the threaded neck 4 of the respective container 2.

More exactly, the single gripping mechanism 17 is associated with the first end 12a of the rod 12 and coupled to second drive means, denoted 18, by which it can be set in rotation independently of other gripping mechanisms 17.

In effect, the second drive means 18 include a plurality of secondary electric motors 18a, each associated with a respective gripping mechanism 17.

In particular, each secondary electric motor 18a is coupled between the first end 12a of the respective rod 12 and the gripping mechanism 17, and presents a shaft 19 aligned coaxially with the rod 12 and rotatable about the respective secondary axis 17a.

Accordingly, the gripping mechanism 17 can be set in rotation by activating the secondary electric motor 18a to turn the relative shaft 19

Still more particularly, the gripping mechanism 17 presents a gripper 20 attached to the shaft 19 of the relative secondary electric motor 18a and capable of movement between an open condition (figure 4), in which the corresponding capping assembly 11 is in the first position, and a closed condition (figure 5) in which the corresponding capping assembly 11 is in the second position and the gripper itself engages the relative cap 3. For the sake of clarity, the cap 3 is not shown in figures 4 and 5.

The gripper 20 presents a carrier element 21 of substantially cylindrical appearance, associated in coaxial alignment with the shaft 19 of the secondary electric motor 18a.

The carrier element 21 in turn presents an outer surface to which a plurality of jaws 22 can be hingedly attached.

5 Three such jaws 22 are shown in the example of the drawings, equispaced advantageously at  $120^\circ$ , although the gripper could be equipped alternatively with a greater number of jaws, as dictated by the nature of the process and according to the structure and size of the particular cap 3.

10 The jaws 22 are hinged to the carrier element 21 and pivotable thus about respective axes transverse to the secondary axis 17a, between a position drawn toward one another, corresponding to the closed condition of the gripper 20, and a position spread  
15 apart from one another corresponding to the open condition of the gripper 20.

In particular, each jaw 22 appears as an elongated and curved plate presenting a first end 22a, a second end 22b remote from the first, and an intermediate  
20 portion 22c located between the first end 22a and the second end 22b.

As illustrated in the accompanying drawings, the intermediate portion 22c is located advantageously to coincide with a recessed portion of the jaw 22.

25 Moreover, the intermediate portion 22c is attached to the carrier element 21 by way of an anchor pivot neither described nor illustrated, being familiar in embodiment, on which the respective jaw 22 is able to rock back and forth.

30 The first end 22a carries a following roller 23

associated rotatably with the jaw 22 and presenting an outer surface that projects beyond the dimensional compass of the selfsame jaw.

5 The second end 22b of the jaw 22 presents a contact element 24 contoured advantageously to match a lateral portion of the cap 3 and combining with those of the other jaws 22 associated with the carrier element 21 to grip the cap 3 in readiness for the screwing step.

10 The gripping mechanism 17 further comprises an actuator 25, advantageously of linear type, by which the gripper 20 is caused to alternate between the open condition and the closed condition.

15 In a preferred embodiment, the linear actuator 25 will consist in a vertically reciprocating electric or pneumatic piston 26 associated with a mounting frame 27.

20 In greater detail, as illustrated to advantage in figure 4 and 5, the secondary electric motor 18a is locked to the rod 12 preferably by way of the aforementioned frame 27.

25 The frame 27 consists to advantage in four upright members 28 flanking the secondary motor 18a and extending parallel to the secondary axis 17a. The top ends of the four uprights 28 are connected to a coupling 29 by way of which the first end 12a of the rod 12 and the secondary motor 18a are rigidly associated.

30 The bottom ends of the uprights 28 are connected to a plate 30 disposed transversely to the secondary

axis 17a, which preferably will afford a hole serving to admit the shaft 19 carrying the gripper 20.

This same plate 30 will also carry the linear actuator 25, which is positioned externally of the frame 27 so as to allow the reciprocating movement of the piston 26.

Also associated with the gripping mechanism 17 is a transmission component 31 interposed between the gripper 20 and the actuator 25, by which the movement of the piston 26 is relayed to the jaws 22.

More exactly, the transmission component 31 is composed of a plunger 32, and a mechanical linkage 33 rigidly associated with the plunger 32.

In greater detail, the plunger 32 is substantially frustoconical in appearance and associated coaxially with the shaft 19 of the secondary motor 18a. Thus, the shaft 19 of the secondary motor 18a is inserted through and freely slidably within a clearance hole afforded by the plunger 32.

In addition, the plunger 32 is interposed between the secondary motor 18a and the gripper 20 and presents a top end 32a coupled to the plate 30, and a bottom end 32b offered to the carrier element 21. The top end 32a and the bottom end 32b are interconnected by a downwardly tapered outer surface 32c against which the following rollers 23 of the single jaws 22 are caused to roll.

Still referring to figures 4 and 5, the roller 23 of each jaw 22 is designed to roll vertically against the outer surface 32c of the plunger 32. As a result

of the rolling action, the jaw 22 is caused to rock on the aforementioned pivot between the respective open and closed positions.

5 The mechanical linkage 33 presents a lever 34 of essentially rectangular outline, associated with the aforementioned frame 27. More exactly, the lever 34 presents a first portion 35 at one end, hinged to the piston 26 of the actuator 25, and a second portion 36 at the opposite end, which is hinged to the plate 30.  
10 The first and second portions 35 and 36 are interconnected rigidly by two guide portions 37 positioned one on either side of the frame 27.

It will be seen also that each guide portion 37 presents an opening 37a extending longitudinally  
15 between the first and second portions 35 and 36 and accommodating a relative pin 38.

The pin 38 in question is mounted to a respective cross member 38a slidable vertically on the frame uprights 28. In particular, the cross member 38a  
20 presents vertical portions 38b positioned to coincide with the uprights 28 and fitted with following rollers 38c offered to the first end 32a of the plunger 32.

In this situation, the pin 38 serves as a fulcrum  
25 on which the guide portion 37 is able to pivot, as will be described in due course.

The capping unit 1 further comprises an electronic controller 40 piloting the operation of each primary electric motor 14a and secondary electric motor 18a,  
30 as illustrated schematically in figure 6.

To advantage, the electronic controller 40 consists in an electronic processor of conventional type, which therefore is neither illustrated nor described in detail hereinafter.

5       The electronic controller 40 includes a processing block 41 serving to vary the operating parameters of the primary electric motor 14a and secondary electric motor 18a of each capping assembly 11.

10       More exactly, a signal S1 is sent by the processing block 41 to the primary electric motor 14a indicating the distance that must be covered by the rod 12 to reach the corresponding container 2. The signal S1 is processed according to the height of the container 2 and can differ from one capping assembly 11, hence  
15       one primary motor 14a, to another.

      Similarly, a signal S2 is sent by the processing block 41 to the second electric motor 18a, indicating the moment at which the selfsame motor 18a will be activated. This second signal S2 is transmitted by  
20       the processing block 41 when the capping assembly 11 is in the relative second operating position.

      To advantage, the processing block 41 is connected also to the linear actuator 25, to which it can send a third signal S3 indicating the moment when the  
25       piston 26 will be activated.

      The operation of the unit 1, described thus far in predominantly structural terms, occurs in the following manner.

      An ordered succession of containers 2 is directed  
30       onto the carrier component 5 by the rotary infeed

conveyor 100, each with a respective cap 3 positioned on the neck 4. More precisely, each container 2 is located in a relative seat 9b of the base 9 with the neck 4 directed upwards.

5       As the carrier component 5 rotates, directing the containers 2 toward the rotary outfeed conveyor 105, signals S1, S2 and S3 are sent by the processing block 41 to each capping assembly 11. The signals in question are preset by an operator according to the  
10       operating specifications of the carrier component 5, and to the size of the containers 2.

          Considering just one capping assembly 11 by way of example, a first signal S1 brings the primary electric motor 14a into operation, with the result  
15       that the corresponding gear 15a is caused to rotate and vertical motion induced in the rod 12.

          The gripping mechanism 17 is thus moved into a position of close proximity to the cap 3 of the relative container 2 (corresponding to the second  
20       position of the capping assembly 11).

          A signal S3 is now sent by the processing block 41 to the linear actuator 25, which will cause the gripper 20 to close around the cap 3. More exactly, the piston 26 strokes downwards, forcing the first  
25       end 35 of the lever 34 likewise downwards and the second end 36 of the lever 34 upwards.

          Tilting thus on the pin 38, the lever 34 forces the cross member 38a down so that the respective vertical portions 38b impinge on the plunger 32, and this  
30       likewise is forced downwards.

As the plunger 32 shifts downwards, the roller 23 of each jaw 22 will roll on the outer surface 32c of the selfsame plunger 32 toward the first end 32a.

Consequently, the jaws 22 are constrained to rock  
5 on the relative intermediate portions 22c and drawn toward one another, with the result that the cap 3 is engaged by the contact elements 24 and gripped between the jaws 22.

Thereupon, a signal S2 is sent by the processing  
10 block 41 to the secondary electric motor 18a, which responds by rotating the relative shaft 19 in such a way as to screw the cap 3 onto the threaded neck 4 of the container 2 until a resisting torque registers and the motor 18a is prevented from turning further.  
15 At this point, the secondary electric motor 18a will be shut off by a relative automatic control function of conventional type, which is not described further. Following this deactivation step, a further signal S3 is sent by the processing block 41 to the linear  
20 actuator 25 to reopen the gripper 20.

More exactly, the piston 26 returns to its former position and the plunger 32 returns upward. As a result, the rollers 23 of the gripper jaws 22 roll toward the second end 32b of the plunger 32, causing  
25 the jaws 22 to rock on the pivots and spread.

Once the cap 3 has been released by the gripper 20, the processing block 41 causes the gear 15a to rotate in the opposite direction, raising the rod 12 and returning the capping assembly 11 to the first  
30 position.

With the cap 3 thus screwed onto the neck 4, the container 2 is directed ultimately by the carrier component 5 onto the rotary outfeed conveyor 105 which in turn directs the containers 2 through the second transfer station.

The problems associated with the prior art are addressed by the present invention and the stated objects duly realized.

First and foremost, it will be seen that each capping assembly 11 is equipped with respective first and second drive means 14 and 18 generating the movements needed to screw the cap 3 onto the container.

Consequently, the movements made by each capping assembly 11 can be adjusted independently, and the operation of the assembly thus adapted advantageously to the dimensions of the container 2. In other words, with independent regulation of the capping assemblies and the use of an electronic controller 40, it becomes possible to adjust and control the vertical movement of the rod 12, the rotation of the gripping mechanism 17 and the action of the gripper 20 both independently and on the basis of operating parameters selected according to the angular velocity of the carrier component 5, the physical properties of the container 2 and the cap 3, and the specified tightening torque.

Advantageously, the capping unit 1 is notably versatile in that it can be used with any type of container 2 and is easily programmed and adjusted by

entering instructions via the processing block 41, which might be a conventional PLC, for example.

In addition, all dedicated appliances used for individual types of container are made redundant by the capping unit 1 disclosed, as also are the changes or modifications made to prior art appliances in order to enable their use with containers of different types.

The effect of reducing the number of appliances and change operations is to speed up the production cycle and lower the cost of the end product, as well as rendering the unit 1 itself more compact.

Moreover, the use of electronic systems in place of mechanical components brings the benefit of a reduced maintenance requirement in respect of such systems, and greater compactness of the components by which the capping assemblies 11 are set in motion.